Section 1

Critical Skills Development and Science Education Programs

Supported by the
Department of Energy
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Adventures in Supercomputing Challenge

Program Description

The New Mexico High School Supercomputing Challenge is a two-fold educational program that offers a truly unique experience to students and teachers in our state. Primarily, it is an academic-year-long program in which teams of one to five high school students conduct computational science projects using high-performance supercomputers. Secondly, during the summer months, it is a computational science- and technology-training program for high school teachers.

The program is both an educational experience and a competition that strives to (1) increase students' knowledge of and interest in science-related disciplines, (2) expose students and teachers to computational experiences, (3) promote careers in science and engineering, (4) provide access to high-performance computers, and (5) institute electronic networking among schools.

Student Program

Every registered participant receives an account on a high-performance computer at Los Alamos National Laboratory. This computer is readily accessible via the Internet. If Internet access is not available through school or home, co-sponsor New Mexico Technet provides access to the Internet by providing telephone dial-up accounts.

Each team defines and works on a single computational science project of its own design. Computational science is a discipline in which a scientific problem, be it one of biology, physics, geology, medicine, engineering, or any other field, is modeled by one or more mathematical equations. These equations are typically so computationally intensive that a computer, where the work can be accomplished in relatively little time, must solve them. Similarly, the output can be so complex that a computer must also interpret it.

Primary instruction and support is given to the participants during the year as follows:

- Three-day Kickoff Conference in October—Instruction in project development, teamwork, programming, mathematical modeling, Unix, and other topics.
- School visits to requesting schools in November—Special assistance to schools requesting assistance with computers, networking, programming, or other issues.
- Regional workshops in January—Small workshops held at sponsoring universities and colleges statewide. Students present the progress on their projects and attend classes in programming, computer graphics, and technical writing.
- Project evaluation sessions in February—Semi-formal presentations, also held at sponsoring universities and colleges statewide, to a group of scientists who critique and provide feedback about their projects.
- Year-round online consulting—Technical support from Challenge consultants at Los Alamos National Laboratory by means of e-mail and telephone.

The sponsoring teachers provide year-round instruction and support as well. Many have been trained in the art of computational science during the Summer Teacher Training Sessions made available by the Challenge. Additionally, every effort is made to find mentors to help guide the teams through their projects. Very often, these people formally specialize in the area of science or engineering that the student projects reflect. Various deadlines are posted throughout the year.

In general, the project abstract is due in late October, an interim report by mid-January, and the final report by early April.

The academic-year program culminates with an awards ceremony at the Laboratory (Fig. 1). Project finalists arrive a day in advance to present their projects to a panel of scientists from the national laboratories, industry, and academia. On awards day, prizes and awards are bestowed upon those teams whose projects demonstrate a high level of quality in one manner or another. Additionally, scholarships from universities throughout New Mexico are awarded on an individual basis to qualified Challenge participants. To finish the day off, students partake in special tours, talks, and demonstrations around the Laboratory, as well as a student poster contest.

Teacher Program

During the summer, a two-week Summer Teacher Training Session is held at an institution of higher education in New Mexico. Participating teachers are instructed in such topics as computational science, mathematical modeling, programming, Web page design, networking, and other topics. Additionally, individuals receive three units of graduate credit for their work.

The Challenge pays for instructors, facilities, books, graduate credits, housing, and stipends for food and miscellaneous expenses. Instructors come directly from Los Alamos National Laboratory and help to further enhance the Laboratory's relations with the communities of New Mexico.

Teachers who have attended the Summer Teacher Training Session become better able to support their students' endeavors in the Challenge, as well as develop into healthier computational scientists themselves. Although the days of instruction are intense, teachers always learn a lot and say that they would recommend the sessions to others.

Recruiting Strategy

The Challenge is open to all interested students in grades 9 through 12 on a nonselective basis. The program has no grade point requirement, class enrollment, or computer experience prerequisites. Participants come from public, private, parochial, and home-based schools in all areas of New Mexico. The important requirement for

Figure 1. 2001 Awards Day. First Place Team from Sandia Preparatory School and Judges Special Recognition Award winners from Picacho Middle School (inset).

participating is a real desire to learn about science and computing. Promotion of the Challenge is accomplished through school visits by Challenge coordinators, attendance at conferences and workshops by coordinators and other Laboratory technical staff members for the purpose of encouraging participation, and promotion among their peers by past Challenge participants. In addition, a portion of the Laboratory's booth at Supercomputing '00 was a Challenge display.

Participants are "recruited" to the Laboratory in many informal ways. For example:

- Laboratory employees, who serve as instructors, mentors, and judges, often hire Challenge participants with whom they interact.
- During the three-day Kickoff Conference in October, the Laboratory's Student Programs Office representatives solicit students for future employment.
- Challenge participants are made aware of opportunities and research activities through various talks and demonstrations given by Laboratory personnel during the Awards Day activities in April.
- At various Challenge events around the state, David Kratzer and Eric Ovaska discuss opportunities at the Laboratory with students. From this exposure, we see many top-level students pursuing Laboratory employment.

Performance Objective and Milestones

The primary objective of the Challenge is to foster creativity in devising computational solutions to scientific problems and to make a positive difference in students' lives, motivating them to prepare for the work force of the future. This objective will meet the goals of (1) increasing the quality and diversity of the hiring pool for NNSA laboratories (2) building a pipeline of quality Challenge students targeted as potential critical skills employees, and (3) connecting students and technical staff at the Laboratory.

FY01 Milestones

- Three new scholarships were added this year, for a total of twelve. Compaq gave the Challenge two (2) $2,500 scholarships and one (1) for $3,000. For a complete listing see http://www.challenge.nm.org/scholarships.shtml. During the awards ceremony this year, over $28,000 was handed out in scholarships.
- Three new classes were introduced this year. Perl programming, as well as the StarLogo and Matlab simulation tools have been added to our curriculum. The Challenge continues to provide a boost to schools, giving them access to the latest in computing hardware architectures and programming techniques.
- Middle school students were allowed to participate for the first time. Jean McCray, a technologist from Picacho Middle School in Las Cruces, attended our Summer Teacher Institute at Western New Mexico University. She enrolled 12 of Picacho's best students into the Challenge. One of her teams won the Judges Special Recognition Award.

Since 1990, new organizations in New Mexico have continually joined with the Laboratory and New Mexico Technet to sponsor the Challenge. New sponsors include NASA and Compaq.

Ethnic representation for students can be seen in Chart 1. We believe that the Challenge has been successful in reaching out to a diverse population.

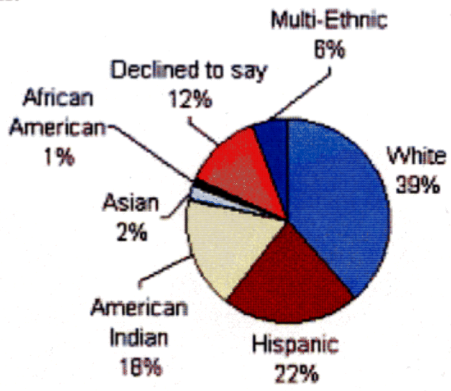

Chart 1. Ethnic representation—Adventures in Supercomputing.

Over 75% were new students and 27% were new teachers of the total student and teacher populations respectively.

The Challenge has directly addressed Los Alamos National Laboratory's Stockpile Stewardship Critical Skills Area #3: HPC- High Performance Computing and Simulation. The official definition of High Performance Computing and Simulation includes: Computer operations—Challenge students learn how to remotely access and operate high-performance computers; computer and computational science and math—students learn computer programming at Challenge events and use computational science and math within their computer programs to carry out their projects; code development and code maintenance—the students continually update and improve their codes over a seven-month period; advanced codes and computation—students have learned advanced programming techniques such as MPI from Challenge events.

The Challenge is also directly aiding in replenishing the essential scientific, engineering, and technical nuclear weapons pipeline and workforce (*Recommendation 7 of the Chiles Commission Report*) by stimulating the interest of and training in the discipline of computational science.

As a direct example, winning teams from the last four years have used a cluster of machines named "Theta" to solve their projects. Theta is a cluster of two SGI Origin 2000s, the same architecture as the Accelerated Strategic Computing Initiative, or ASCI, "Blue Mountain" machine (Fig. 2).

ASCI is a tri-laboratory and Defense Programs (DP) collaboration that will create the leading-edge computational modeling and simulation capabilities that are essential for maintaining the safety, reliability, and performance of the US nuclear stockpile and reducing the nuclear danger. Blue Mountain is a machine that assists in this mission and eliminates the need for underground nuclear testing.

Most importantly, October 2000 marked the beginning of the eleventh year of the Challenge. The Challenge staff has been proud to offer our services to communities of New Mexico during the past decade.

Highlights of This Year's Accomplishments

Analysis of Direct Impact on Laboratory

We took the Challenge student and teacher data from October 1990 through October 2000 and matched it up with the Laboratory's Employee Information System database. There are 209 matches of people who have been Challenge participants who also have been employed at the Laboratory at some time. Sixty-nine of those 209 are currently employed at the Laboratory.

Figure 2. Overview of the ASCI Blue Mountain Supercomputer.

Kickoff Conference
Over 300 participants gathered at the Glorieta Conference Center to begin the Challenge year. The Challenge was able to obtain Karen G. Haines, (a postdoctoral fellow from the Albuquerque High Performance Computing Center) to deliver the keynote speech. She presented an engaging discussion on her work entitled "Using Computational Science and Scientific Visualization to Model the Fly's Early Visual Processing."

November School Visits
During November, Challenge representatives from the Laboratory traveled to various high schools in Northern New Mexico to assist students and teachers with their projects. Individualized instruction was also provided in computer programming and Web design.

Regional Workshops
A great success this year was "Meet the Scientist Luncheon" at the regional workshops. Over lunch, local faculty members and scientists discussed teams' projects with them, offered suggestions, and lent support to ideas. Also of interest this year were computer ethic discussions—in particular issues concerning "free" music trading over the Internet.

Promotion
Several times during the year, Challenge coordinators attended conferences and workshops to promote the Challenge and encourage participation by others. Included this year were visits with the following groups: Mexican American Engineers and Scientists (MAES); Women in Science—Expanding your Horizons; Math, Engineering, and Science Achievement (MESA); and various state Chambers of Commerce.

Awards Day Ceremony
The Challenge competition came to a conclusion in April when about 150 participants came to Los Alamos. Laboratory scientists gave them tours that included scientific talks. Additionally, the participants were able to see the computers that they had been working on while viewing the Laboratory Data Communication Center machine room. Approximately 90 Laboratory personnel were involved with the activities in one way or another.

A team of three sophomore girls from Sandia Preparatory School won the top honors. An official Laboratory press release provided more details.

Summer Teacher Training Session
In June, a two-week-long Summer Teacher Institute was held at New Mexico Tech (NMT) in Socorro, New Mexico (Fig. 3). This event was sponsored in part by NASA and Tennessee State University.

Participating were over 20 teachers from around the state, receiving three units of graduate credit each from NMT. They were instructed in C++, Unix, HTML, and other topics.

Year-Round Online Consulting
Our set of online tutorials was expanded to cover more topics. More information on the Java programming language was added to provide step-by-step instructions for participants who wish to learn this language.

Other
The Challenge has had a positive impact on students, teachers, schools, and communities throughout New Mexico. As a result, the Laboratory's participation has had a positive effect on participants' perception of the Laboratory. Additionally, the Laboratory has been able to use the Challenge to promote good neighbor practices and received a lot of positive press coverage due to the Challenge.

The Laboratory and the other Challenge sponsors look forward to their contributions to the future participants and the world in which they will live.

Figure 3. Teachers and staff at the Summer Teacher Institute at New Mexico Tech.